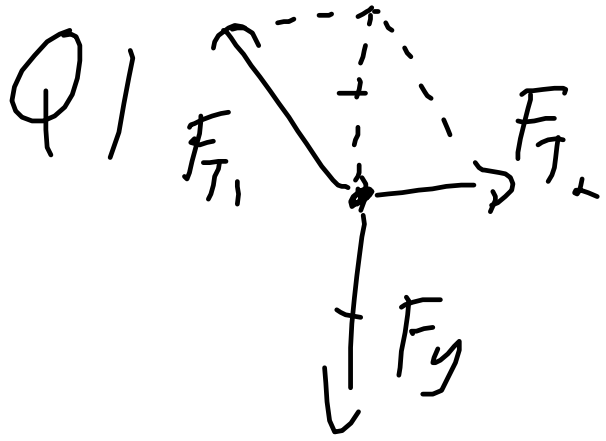
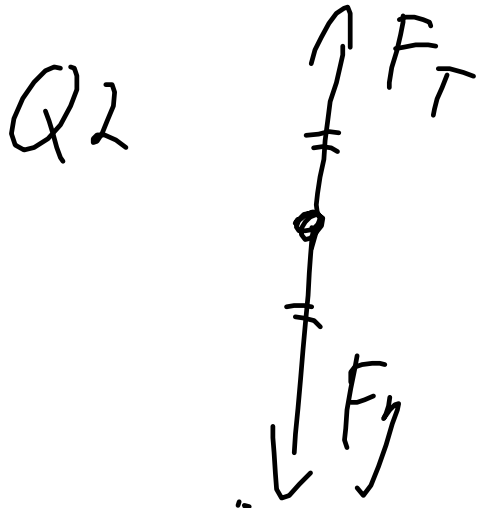
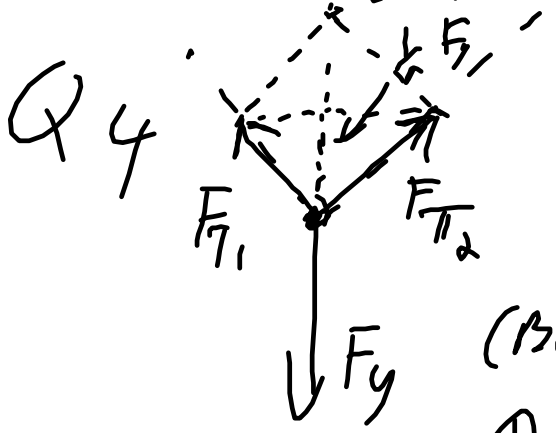
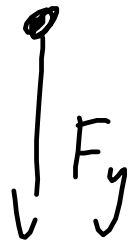
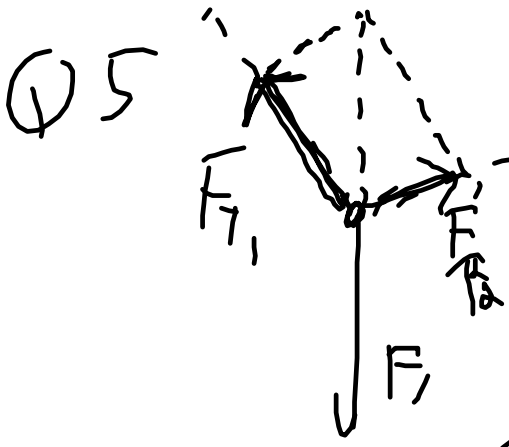
Free body diagram worksheet

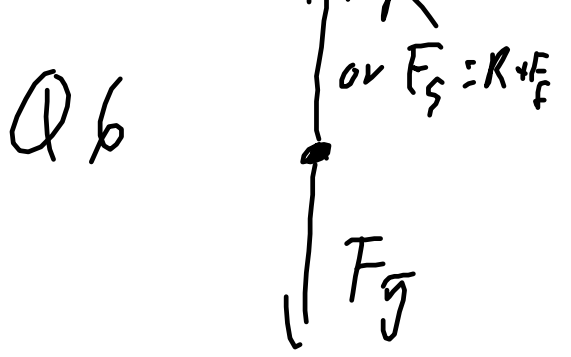












F_S = Surface Force $= \vec{F_f} + \vec{R}$

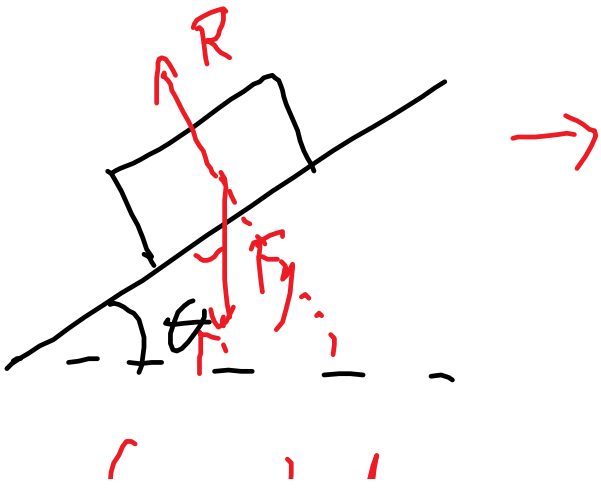
Slopes and Pulleys

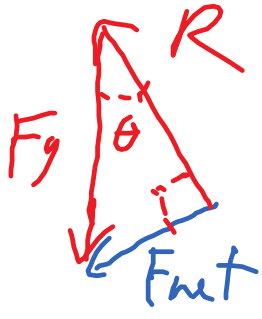
Determine the net force and acceleration of blocks on slopes and masses connected by pulleys.

Start with Free body diagram of forces, convert to a vector addition diagram (head to tail) and calculate resultant using trig - cosine law or components.

Look at a block on a slope. What is the acceleration of the block if the slope is

a) frictionless
b) coefficient of static friciton μ_s and kinetic friciton, μ_k.
c) the block is connected over a pulley to another block





Vector Addition

free body

Vector Addition

$\rightarrow F_{net} = F_g \sin\theta$

Component of F_g parallel to the slope ∥

$$\boxed{F_{g_{\parallel}} = F_g \sin\theta}$$

$R = F_g \cos\theta$

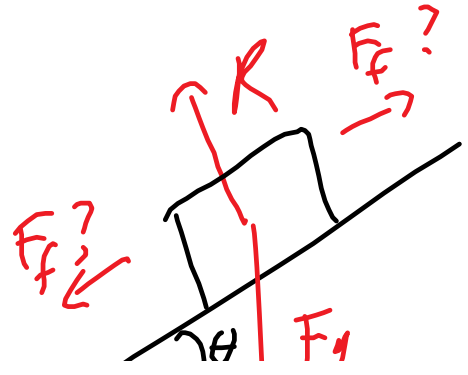
→ Perpendicular component of F_g,

$$\boxed{F_{g_{\perp}} = F_g \cos\theta}$$

$$a = \frac{F_{net}}{m} = \frac{mg\sin\theta}{m}$$

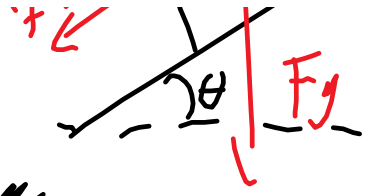
$$\boxed{a = g\sin\theta}$$

b)



F_{f_k} is opposite velocity/

F_r is opposite

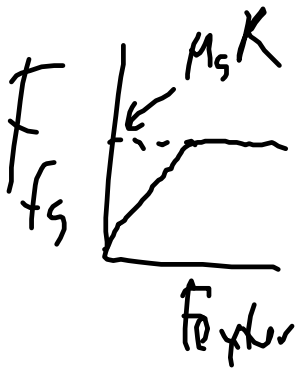


F_{fs} is opposite external forces

$$F_{f_k} = \mu_k R$$

$$F_{fs} \leq \mu_s R$$

↑ depends on external forces



$$F_{net} = \Sigma F_{||} = F_{g||} \pm F_f$$

$$ma = mg\sin\theta \pm \mu mg\cos\theta$$

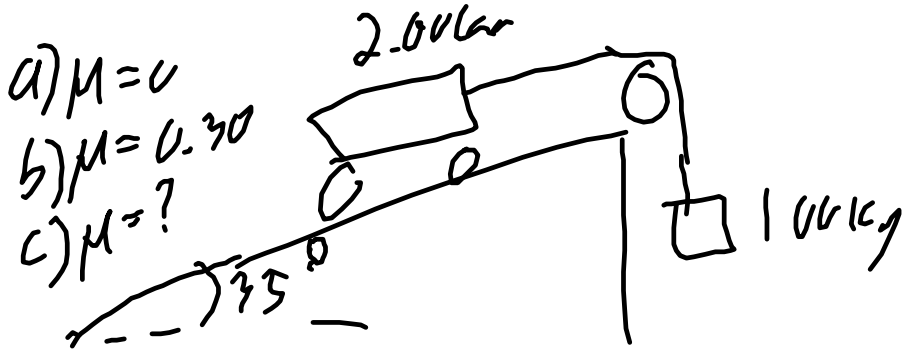
$$\boxed{a = g\sin\theta \pm \mu g\cos\theta}$$

A 2.00 kg cart is on a 35.0º slope.
Determine the acceleration of the cart if
a) it is frictionless

b) the friction in the wheels corresponds to a coefficient of 0.30.

c) what coefficient of static friction would prevent rolling?

d) the 2.00kg cart is connected by a string up the slope over a pulley to a 1.00 kg mass hanging off the table. Answer a,b,and c again.



$$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{0.981m}{9.81 m/s^2}}$$

$$= \quad m \div m/s^2$$

$$m \times \frac{s^2}{m}$$

b) $x = 0.30m \cos(3.14t)$

$$\omega = \frac{2\pi}{T}$$ Radians

c) $V_{max} = \omega x_0 = 3.14 \times 0.3$

$= 0.94 m/s$

d) $V = V_{max} \sin \omega t$

$V = 0.94 \sin\{3.14(0.25)\}$

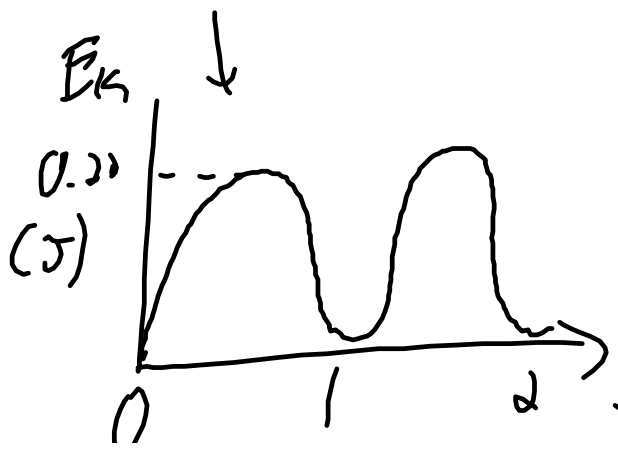
$= 0.67 m/s$

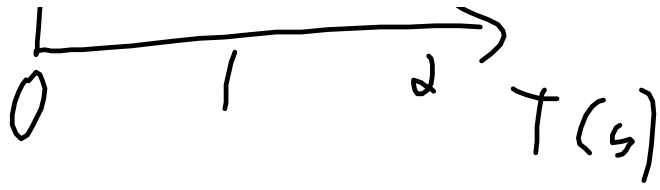
$E_K = \frac{1}{2} m v^2 = \frac{1}{2} m \left(\omega \sqrt{x_0^2}\right)^2$

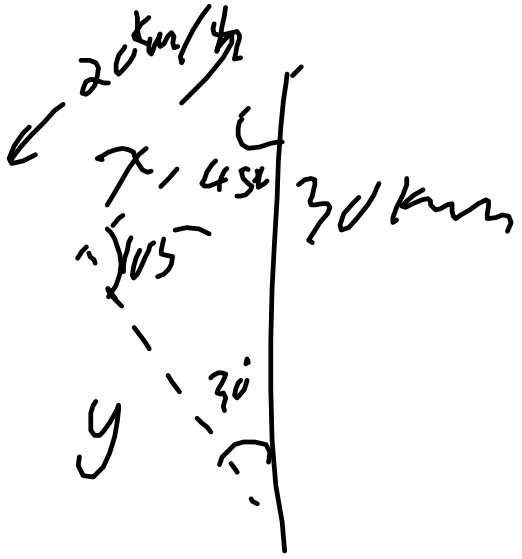
$= \frac{1}{2} m \omega^2 x_0^2$

$= \frac{1}{2}(0.5)(3.14)^2 (0.3)^2$

$= 0.22 J$







$$\frac{\sin 30}{x} = \frac{\sin 105}{30}$$

$$x = d$$

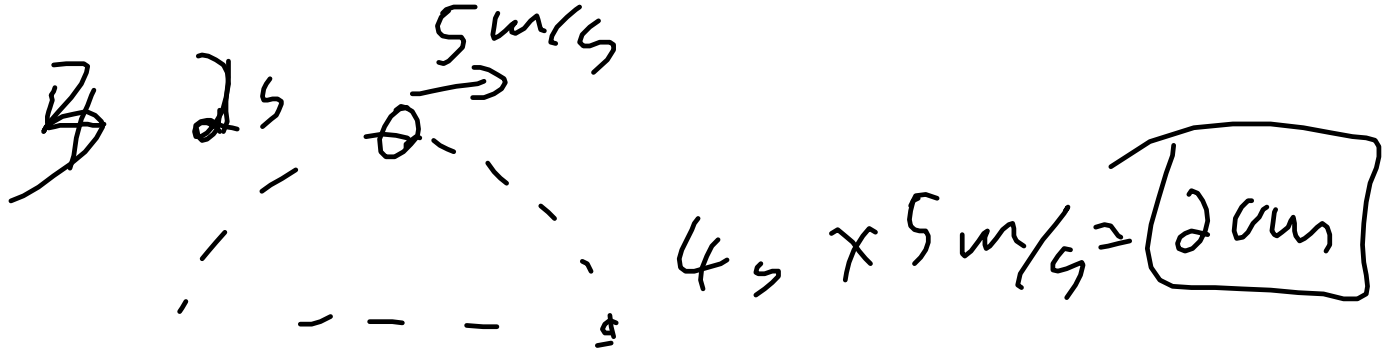
$$t = \frac{d}{20 \text{ km/h}}$$

$$\frac{\sin 45}{y} = \frac{\sin 105}{30}$$

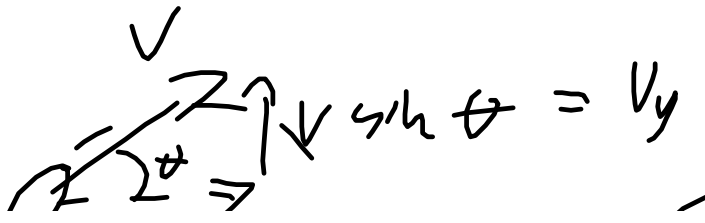
$$V = \frac{y}{t}$$

$$= 28 \text{ km/h}$$

$$20 \sin 45 = V \sin 30$$



4)



Vcosθ

s = 1-120

$S_x = 760m$